one in 10^6 particles with a diameter greater than about two times the average diameter.

17. (Amended) A method for producing a collection of aluminum oxide particles having an average diameter from about 5 nm to about 500 nm, the method comprising pyrolyzing a molecular stream in a reaction chamber, the molecular stream comprising an aluminum precursor, an oxidizing agent, and an infrared absorber, where the pyrolysis is driven by heat absorbed from a continuous wave laser beam.

REMARKS

Claims 1-3 and 5-22 remain for consideration. Applicants have updated references in the Specification. In addition, Applicants have amended claims 1 and 17 to more specifically claim their invention and have amended claim 5 for clarity. The amendment of claim 1 is supported by the specification, for example, at page 19, lines 15-19. The amendment of claim 5 is supported by the specification, for example, at page 21, lines 3-10. The amendment of claim 17 is supported by the specification, for example, at page 5, lines 1-2, page 8, lines 16-27 and page 12, lines 1-11. No new matter is introduced by the amendments to the claims.

Objections to the Specification

The Examiner noted that application serial numbers had to be updated if appropriate. Applicants have updated all appropriate applications.

Rejections Under 35 U.S.C. §112

The Examiner rejected claim 5 under 35 U.S.C. §112, second paragraph as being indefinite. In particular, the Examiner indicated that the phrase "effectively no" rendered the claim indefinite. While Applicants do not believe that this phrase is indefinite, Applicants have amended claim 5 to remove this language. Applicants respectfully request the withdrawal of the rejection to claim 5 under 35 U.S.C. §112, second paragraph as being indefinite.

Rejections of Claims 1-3, 5-8 and 19-22 Under 35 U.S.C. §103(a)

The Examiner rejected claims 1-3, 5-8 and 19-22 as being unpatentable over any one of U.S. Patent 4,861,572 to Sugoh et al. (the Sugoh patent), U.S. Patent 4,705,762 to Ota et al. (the Ota patent), U.S. Patent 5,635,154 to Arai et al. (the Arai patent), U.S. Patent 5,417,956 to Moser (the Moser patent) and U.S. Patent 5,447,708 to Helble et al. (the Helble '708 patent). The Examiner cited these five references for teaching particle sizes within the claimed range. Applicants believe that each of these references have significant deficiencies with respect to teaching or suggesting Applicants' claimed invention. Applicants attempt to clarify the nature of these deficiencies in the following analyses.

Assertions in a prior art reference do not support an anticipation or obviousness rejection unless the references place the claimed invention in the hands of the public. Beckman Instruments Inc. v. LKB Produkter AB, 13 USPQ2d 1301, 1304 (Fed. Cir. 1989). "In order to render a claimed apparatus or method obvious, the prior art must enable one skilled in the art to make and use the apparatus or method." Id. While a reference is prior art for all that it teaches, references along with the knowledge of a person of ordinary skill in the art must be enabling to place the invention in the hands of the public. In re Paulsen, 31 USPQ2d 1671, 1675 (Fed. Cir. 1994). See also In re Donohue, 226 USPQ 619, 621 (Fed. Cir. 1985).

"In rejecting claims under 35 U.S.C. §103, the examiner bears the initial burden of presenting a prima facie case of obviousness. In re Rijckaert, 28 USPQ2d 1955, 1956 (Fed. Cir. 1993). "Only if that burden is met, does the burden of coming forward with evidence or argument shift to the applicant." Id. All claim limitations must be taught or suggested by the prior art. See MPEP 2143.03. "Obviousness cannot be predicated on what is unknown." In re Rijckaert, 28 USPQ2d at 1957, citing In re Spormann, 150 USPQ 449, 452 (CCPA 1966).

With respect to the **Sugoh** patent, Applicants did **not** assert that the Sugoh patent failed to disclose alumina. On the other hand, the Sugoh patent describes a solution based method for the production of metal oxides. Examples 1 and 2 of the Sugoh patent relate to silica (SiO_2). The particle size growth for the silica particles is shown in Fig. 5. Table 1 includes a summary of the final particle sizes for aluminum oxide. The Sugoh patent does not teach or suggest the claimed narrow particle size distributions claimed by Applicants. The Examiner has not considered the structural feature in the claims relating to the particle size distribution. But this feature must be considered with respect to patentability as other structural features in the claim.

With respect to the **Ota** patent, the Ota patent like the Helble patent described below discloses a flame synthesis approach. The Ota patent does not describe the production of particles with a narrow size distribution as disclosed and claimed by Applicants. With respect to aluminum oxide, the Ota patent describes the production of particles with a range from 10-100 nm, see Table 1 of the Ota patent. The Helble patent similarly describes their particles as having a range of particles sizes from 10-100 nm, see column 5, lines 57-59 of the Helble patent. But the corresponding particle size distribution does not fall within Applicants' claimed range. The Helble patent is described in detail below. The Ota patent, like the Helble patent does not teach or suggest Applicants' claimed invention since particle are not disclosed with Applicants' claimed narrow particle size distribution.

With respect to the **Arai** patent, Applicants do not disagree that the Arai patent discloses the production of metal oxides. But Applicants assert that **these metal oxides do not include alumina**. The Arai patent discloses the production of iron oxide, nickel oxide and **aluminum oxyhydroxide**. See column 4, lines 31-34 and Table 1. It is ambiguous from the disclosure of the Arai patent whether they consider aluminum oxyhydroxide to be a metal oxide.

On the other hand, it is clear from Applicants' specification and from conventional usage that **aluminum oxyhydroxide** is not a metal oxide. Applicants have enclosed relevant pages from the CRC Handbook of Chemistry and Physics to indicate the distinction between aluminum oxide with a hexagonal crystal structure (Al_2O_3) and aluminum oxyhydroxide with an orthorhombic crystal structure (AlOOH). The Arai patent does not claim to be able to produce aluminum oxide, the method evident produces aluminum oxyhydroxide rather than aluminum oxide. Thus, the Arai patent does not teach or suggest Applicants claimed invention.

With respect to the **Moser** patent, the Moser patent describes a solution based approach for the production of metal oxide powders. Applicants note that in Table II of the Moser patent, the chemical formula is presented for each of the species except for the aluminum species. This strongly suggests that Moser et al. were not confident that they had produced alumina (Al_2O_3). At column 6, lines 1-6, the Moser patent indicates that Transmission Electron Microscopy was used to evaluate **each** of the materials. However, no particle morphology or particle size is given for alumina. Thus, the results in the Table suggest that no nanoscale particles were formed of alumina. Even for the TiO_2 particles, Fig. 6 of the Moser patent shows large agglomerates with no distinguishable particles indicative of a particle size distribution extremely different from the distributions disclosed and claimed by Applicants.

With respect to the **Helble** patent, the Helble patent relates to a flame synthesis method for the production of ceramic powders. The particle size distribution claimed by Applicants is not disclosed by the Helble patent. Furthermore, the Helble patent does not teach or suggest how to obtain a particle size distribution as claimed by Applicants. The derivative of the particle size distribution as a function of **log particle diameter** is plotted in Fig. 4. The average particle size is 40 nm (column

9, lines 7-11). First, the distribution has a significant tail extending out well beyond three times the average diameter. Also, the distribution is wide at both large and small diameters. Thus, the distribution does not fall within the particle size distribution claimed and disclosed by Applicants.

The limitations of the disclosure of the Helble patent are not limited to the preferred embodiments. The approach described by the Helble patent are not satisfactory for the production of particles with the characteristics disclosed and claimed by Applicants. These differences are immediately visible by comparing the micrographs in Fig. 3 of the Helble patent with the micrographs in Applicants application. The micrographs in Fig. 3 of the Helble patent disclose a wide range of particle sizes from very small to many fold larger. Due to the deficiencies of the Helble patent, the Examiner has failed to establish that the claimed invention is prima facie obvious over the Helble patent.

Since none of the five references presented by the Examiner teach a person of skill in the art to practice Applicants' claimed invention, the references do not render Applicants claimed invention obvious. Applicants respectfully request the withdrawal of the rejection of claims 1-3, 5-8 and 19-22 as being unpatentable over any one of the Sugoh patent, the Ota patent, the Arai patent, the Moser patent and the Helble '708 patent.

Rejection of Claims 1-3, 5-16 and 19-22

The Examiner rejected claims 1-16 and 19-20 under 35 U.S.C. §103(a) as being unpatentable over either U.S. Patent 5,804,513 to Sakatani et al. (the Sakatani patent) alone or in view of U.S. Patent 5,697,992 to Ueda et al. (the Ueda patent), the Ueda patent alone, U.S. Patent 5,868,604 to Atsugi et al. (the Atsugi patent) alone or in view of the Ueda patent, U.S. Patent 4,021,263 to Rosenblum (the Rosenblum patent) alone or in view of the Ueda patent, U.S. Patent 5,228,886 to Zipperian (the Zipperian patent) alone or in view of the Ueda patent, U.S. Patent 5,300,130 to

Rostoker (the Rostoker '130 patent) alone or in view of the Ueda patent, U.S. Patent 5,389,194 to Rostoker et al. (the Rostoker '194 patent) alone or in view of the Ueda patent, or U.S. Patent 5,527,423 to Neville et al. (the Neville patent) alone or in view of the Ueda patent. The Examiner points to various citations in these patent referring to aluminum oxide particles having a nanometer size. Applicants note that claims 1 and 19 have an additional limitation related to the particle size distribution. In view of this additional limitation, Applicants believe that all of these references contain significant shortcomings.

The Examiner argues that the claims are prima facie obvious because the references disclose overlapping ranges. Overlapping ranges could make the claims prima facie obvious. However, the claims do not have ranges overlapping with the cited references. In particular, claim 1 indicates that "less than about one in 10^6 particles have a diameter greater than about three times the average diameter of the collection of particles." The Examiner has failed to present a range in any of the references that overlaps with this size range. Similarly, claim 19 indicates that the particles have "a distribution of particle sizes such that at least about 95 percent of the particles have a diameter greater than about 40 percent of the average diameter and less than about 160 percent of the average diameter." **All claim limitations must be taught or suggested.** See MPEP 2143.03. Again, the Examiner has failed to point to disclosure in the cited references that overlap with the claimed ranges relating to the particle size distribution. While the references overlap with the claimed average diameter, they do not overlap with the other features of the claimed invention, in particular the claimed particle size distribution. Thus, prima facie obviousness is not established.

Of the eight patents cited in this rejection, only the Rostoker '194 patent and the Neville patent seem to discuss or disclose particle size distributions. In the Amendment of June 16,

1999, Applicants raised the issue of their production approach in the context of their approach being suitable for the production of nanoparticles with a narrow size distribution. Methods of production are relevant to the extent that the prior art does not enable production, see MPEP 2121.02. However, this is only relevant with respect to the Rostoker '194 patent. Arguments regarding methods capable of producing extremely uniform particles with a narrow size distribution are discussed below in the context of the Rostoker '194 patent. Since the other references besides the Neville patent and the Rostoker '194 patent do not teach or suggest particles size distributions, the relevance of the other references is unclear. While a reference can be used for all that it teaches and not just the preferred embodiments, a reference is not good for what it does not teach or suggest at all.

The Neville patent not only describes polishing with alumina particles with an average diameter less than 500 nm, but the patent also describes the production approach and particle size distribution of the secondary particles in a dispersion. The Neville patent discloses a flame synthesis approach without disclosing significant details of the process, column 6, lines 6-34. The secondary particle size distribution for flame synthesized particles is presented in Fig. 2 of Neville. No information is presented for the primary particle sizes, although the primary particles sizes for flame synthesized particles is presented by the Helble '708 patent, as described above. The Neville patent does not give the details of their flame synthesis approach. However, their secondary particle size distribution is significantly narrower than the primary particle size distribution of particles produced by a flame synthesis approach described in the Helble '708 patent, for example, see figure 4 of the Helble '708 patent discussed above. However, even the narrow secondary particle size distribution shown in Fig. 2 of the Neville patent is considerably broader than the distribution disclosed and claimed by Applicants.

Assuming that the secondary particle size distribution presented in the Neville patent corresponds to the primary particle size distribution, with respect to Applicants' claim 1, the distribution in Fig. 2 of the Neville patent has a significant tail. At the tail, the distribution is dropping off about a factor of five for every 50 nm along the Y axis. Thus, the distribution would not fall off to having less than 1 per million particles until about 500 nm, more than a factor of five greater than the average diameter. Nevertheless, Applicants have amended claim 1 to indicate that the particle size distribution has a value of less than 1 per million particles by a diameter that is a factor of three relative to average diameter. As presently amended, Applicants' claim 1 accounts for any possible moderation of the tail in the Neville distribution at larger particle diameters. However, any error in the tail of the distribution shown in the Neville patent almost certainly would correspond to a corrected distribution with an extended tail more similar to the tail shown in the Helble '708 patent.

Thus, the Neville patent falls far short of Applicants' claimed distribution. With respect to claim 19, the Neville patent is significantly broadened at both small particle sizes and at larger particles sizes relative to Applicants' claimed distribution. In conclusion, the Neville patent does not teach or suggest Applicants' claimed invention.

With respect to the Rostoker '194 patent, the Rostoker patent does not teach or suggest how to produce the polishing particles with the described narrow particle size distribution. "With respect to the prior art printed publications, these references must be enabling, thus placing the alleged disclosed matter in possession of the public." In re Epstein, 31 USPQ2d 1817, 1823 (Fed. Cir. 1994). "To explain, when the PTO cited a disclosure which expressly anticipated the present invention, ..., the burden shifted to the applicant. He had to rebut the presumption of the

operability of [the reference] by a preponderance of the evidence." In re Sasse, 207 USPQ 107, 111 (CCPA 1980).

The Rostoker patent described the use of nanoparticles of Al_2O_3. The Rostoker patent discloses only one approach for obtaining nanoparticles of Al_2O_3, a process described in U.S. Patent 5,128,081 to Siegel et al. (the Siegel patent). However, the Rostoker patent mischaracterizes the properties of the particles obtainable by the process described in the Siegel patent. Significantly, the Siegel patent does not describe the production of nanoparticles with extremely narrow particle size distributions. In fact, the approach described by the Siegel patent using a cold finger that is scrapped is not suitable for the production of particles with an extremely narrow particle size distribution, as claimed by Applicants.

The Rostoker patent describes that a "distribution of particle sizes is controlled to within 'Y' nm." Column 6, lines 8-9. At column 6, lines 14-17, "Y" is described more fully as:

> "Y" is approximately "P" percent of "X", where "P" is 10%, 20%, 30%, 40%, or 50%, and is preferably no greater than 50% to ensure a narrow (Gaussian) distribution of particle sizes about "X"; . . ..

Thus, the Rostoker patent admits that the particle size distribution is a gaussian distribution with a corresponding large tail corresponding to a small but significant number of particles with diameters considerable larger than average. The meaning of "Y" though is still not clear from this description. "Y" is further defined as the inverse of "Q", but the definition of "Q" is no clearer than of "Y".

The precise meaning of "Y" is not significant, though, since the more relevant issue is whether the Rostoker patent enables the practice of Applicants' claimed invention. Applicants believe that it does not. The Siegel patent describes the use of a gas phase condensation approach to producing the particles. This approach

leads to a tail at larger particle sizes that brings the distribution outside of Applicants claimed ranges. As evidence of this, Applicants enclosed a copy of a reference by Siegel et al., J. de Physique C5: Supplement 10 681-686 (October 1988) with their earlier Amendment. The inset in figure 1 shows a particle size distribution for titanium dioxide produced by the gas phase condensation approach. The discussion below figure 1 refers to the distribution as "typical of the particle-size distribution produced in the gas-condensation method."

The long tail at larger particle sizes in the distribution clearly distinguishes the materials from those claimed by Applicants. The average "grain size" is about 13 nm, and a significant fraction of the particles have a size larger than 160 percent of the average, i.e., about 21 nm. The elimination of larger particle sizes is critical for polishing applications since larger particles can scratch the surface of the material being polished.

With respect to other availability of the aluminum oxide nanoparticles with a narrower size distribution, we note that Dr. Siegel was instrumental in the formation of Nanophase Technologies Corporation (Nanophase). Nanophase was not able to scale up easily the gas-condensation approach described in the Siegel patent. Thus, a variation on the gas-condensation approach was developed, called Physical Vapor Synthesis Approach. While this new approach is suitable for the production of commercial quantities of powders, the particle size distributions for Physical Vapor Synthesis are considerable **broader** than those obtained by the gas condensation approach. Applicants enclosed with their earlier amendment an advertisement article by Quinton Ford of Nanophase and pages down-loaded from the Nanophase web site that confirm this conclusion. Therefore, the nanoscale particles needed to form the dispersions claimed by Applicants' claim were not commercially available.

With respect to claim 15, the gas condensation approach and the Physical Vapor Synthesis Approach both produce particle size distributions that are gaussian in character. Gaussian distributions inherently have a long extending tail. Part of this tail can be seen in the distribution in the Siegel et al. reference enclosed. Thus, these approaches will result in particles with a diameter that is five times larger than the average particle size. Therefore, the Rostoker patent does not anticipate Applicants' claim 15.

While the Rostoker patent discloses a desire to use abrasive nanoparticles with a narrow size distribution, the Rostoker patent does not teach or suggest how to accomplish this desire. If the required aluminum oxide particles were not available by the approach described in the Siegel patent or commercially available from Nanophase, a person of skill in the art could not have practiced Applicants' claimed invention based on the disclosure in the Rostoker patent. Thus, the Rostoker patent is not enabling for the practice of Applicants' claimed invention and does not place the public in possession of Applicants' invention.

In conclusion, none of the cited references teach or suggest the narrow particle size distribution of alumina nanoparticles as disclosed and claimed by Applicants. Applicants respectfully request the withdrawal of the rejection of claims 1-16 and 19-20 under 35 U.S.C. §103(a) as being unpatentable over either the Sakatani patent alone or in view of the Ueda patent, the Ueda patent alone, the Atsugi patent alone or in view of the Ueda patent, the Rosenblum patent alone or in view of the Ueda patent, the Zipperian patent alone or in view of the Ueda patent, the Rostoker '130 patent alone or in view of the Ueda patent, the Rostoker '194 patent alone or in view of the Ueda patent, the Wang patent alone or in view of Ueda, or the Neville patent alone or in view of the Ueda patent.

Thus, the Examiner has failed to establish prima facie obviousness. However, Applicants' specification further describes advantages of the aluminum oxide particles with a narrow size distribution, in particular, at page 4, lines 6-18 and at page 24, lines 28-32.

Applicants respectfully request the withdrawal of the rejection of claims 1-16 and 19-20 under 35 U.S.C. §103(a) as being unpatentable over either the Sakatani patent alone or in view of the Ueda patent, the Ueda patent alone, the Atsugi patent alone or in view of the Ueda patent,the Rosenblum patent alone or in view of the Ueda patent, the Zipperian patent) alone or in view of the Ueda patent, the Rostoker '130 patent alone or in view of the Ueda patent, the Rostoker '194 patent alone or in view of the Ueda patent, or the Neville patent alone or in view of the Ueda patent.

Rejection of Claims 17 and 18 Over Shimo

The Examiner rejected claims 17 and 18 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent 5,064,517 to Shimo (the Shimo patent). The Examiner cites the Shimo patent for disclosing Applicants' claimed invention for the production of nanoscale aluminum oxide particles. Applicants believe that the Shimo patent does not teach or suggest Applicants' process. Applicants have amended claim 17 to more specifically claim their invention. Applicants respectfully request reconsideration of the rejection of claims 17 and 18 based on the following comments.

Applicants have amended claim 17 to explicitly specify that a continuous wave (cw) laser is used in the method. The Shimo patent specifies explicitly that a laser pulse should be used. In fact, the Shimo patent teaches away from Applicants' claimed method. At column 7, lines 33, the Shimo patent states that "It is an advantageous condition that the width of a single pulse of the pulse-wise irradiation in the inventive method be as small as possible so as to produce the active species in a unit of time in a concentration as high as possible."

Since the Shimo patent teaches away from a method based on a continuous wave laser, the Shimo patent does not render claims 17 and 18 obvious. Applicants note that differences between combustion reactor and laser pyrolysis, as described by Applicants, is emphasized in their specification at page 8, lines 16-27. Applicants respectfully request the withdrawal of the rejection of claims 17 and 18 under 35 U.S.C. §103(a) as being unpatentable over the Shimo patent.

Rejection of Claims 17 and 18 Over A Combination of References

The Examiner rejected claims 17 and 18 under 35 U.S.C. §103(a) as being unpatentable over the references cited against claim 1 further in view of the Shimo patent. The Examiner argues that it would have been obvious to manufacture the aluminum oxide particles described by the references cited against claim 1 using the method disclosed by the Shimo patent. Applicants respectfully request reconsideration based on the following comments.

As noted above, the Shimo references teaches away from Applicants' claimed invention. In particular, the Shimo reference is a process that uses a pulse of a laser to initiate the reaction in a batch of reactants. In contrast, Applicants' approach is a continuous production process using either a batch or continuous collection scheme that uses a continuous wave laser to produce extremely uniform particles. None of the other cited references disclose a laser based production method. Therefore, the combination of references does not teach or suggest Applicants' claimed method using a continuous wave laser. Applicants respectfully request the withdrawal of the rejection of claims 17 and 18 under 35 U.S.C. §103(a) as being unpatentable over the references cited against claim 1 further in view of the Shimo patent.

Double Patenting Rejections

The Examiner provisionally rejected claims 1-16 and 19-20 under the judicially created doctrine of obviousness-type double

patenting over claims 1-3, 5-9 and 11-16 of copending Application No. 08/961,735 (the '735 application). The Examiner asserts that the presently claimed particles were well known abrasive particles. However, the claims of the '735 application do not disclose particles wherein no more than one particle in 10^6 have a diameter greater than a factor of four greater than the average particle diameter. This lack of a tail in the particle size distribution does not follow from the claims of the '735 patent. Therefore, the present claims are not obvious over the claims of the '735 patent. Applicants respectfully request the withdrawal of the rejection of claims 1-16 and 19-20 under the judicially created doctrine of obviousness-type double patenting over claims 1-3, 5-9 and 11-16 of copending Application No. 08/961,735.

CONCLUSIONS

In view of the above amendments and remarks, Applicants submit that this application is in condition for allowance, and such action is respectfully requested. The Examiner is invited to telephone the undersigned attorney to discuss any questions or comments that the Examiner may have.

The Commissioner is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

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